# Software Architecture of the Light Weight Kernel, Catamount

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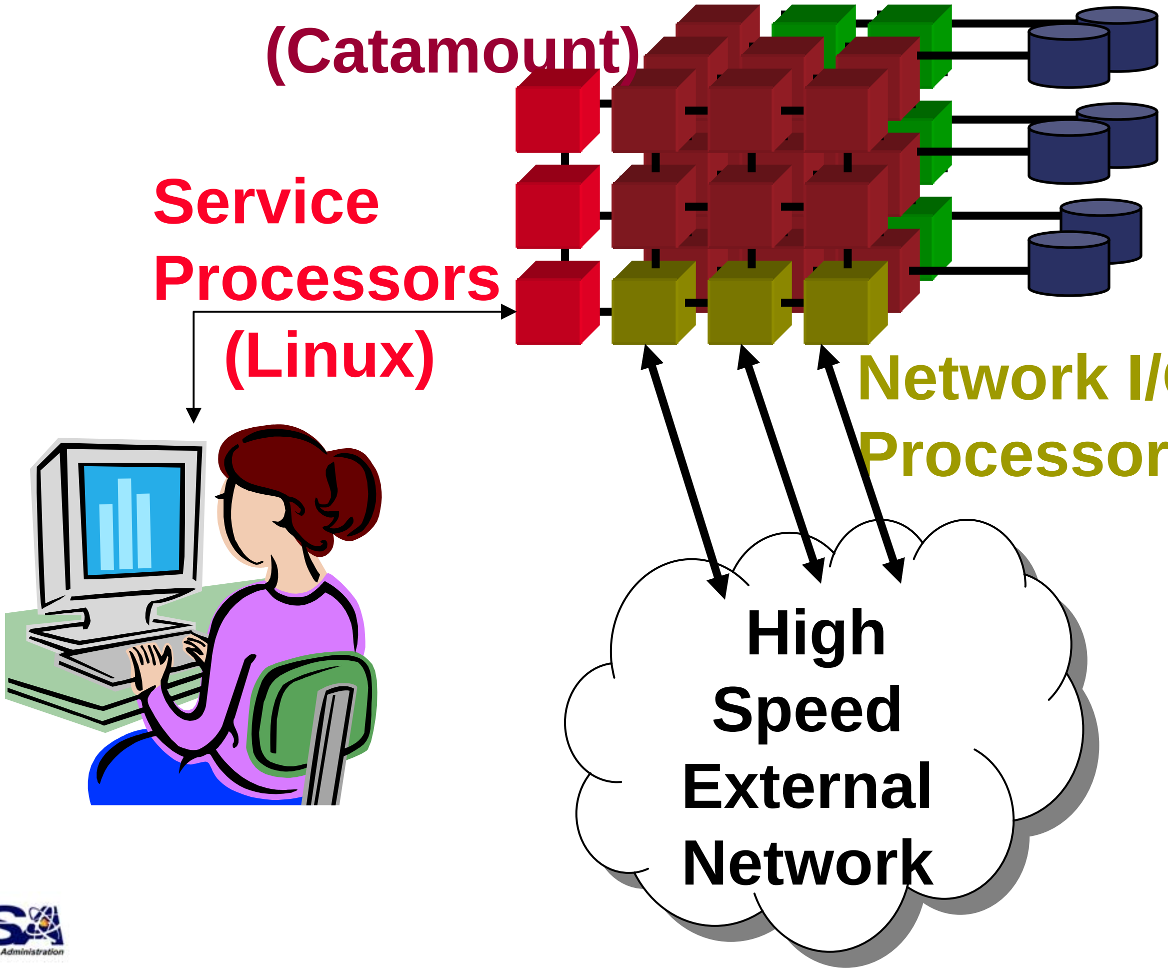
# SUNMOS, PUMA, Cougar, Catamount Design Goals

- Targeted at massively parallel environments comprised of thousands of processors with distributed memory and a tightly coupled network.
- Provide *necessary* support for scalable, performance-oriented scientific applications
- Offer a suitable development environment for parallel applications and libraries.
- Emphasize efficiency over functionality.
- Maximize the amount of resources (e.g. CPU, memory, and network bandwidth) allocated to the application.
- Seek to minimize time to completion for the application.

# Catamount is designed for an MPP environment with functional partitions



Compute Processors (Catamount)

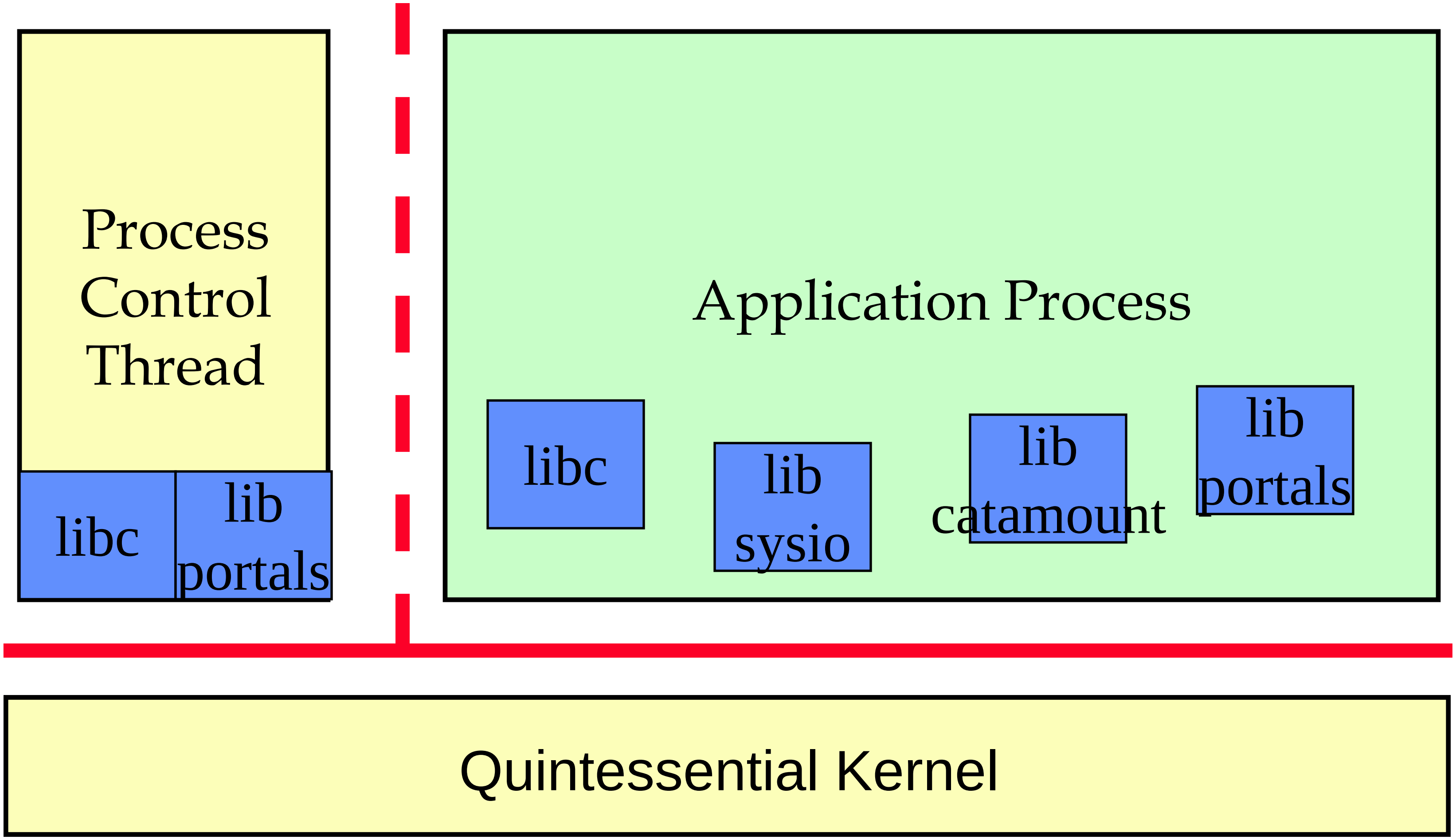
I/O processors (Linux)

Service Processors (Linux)

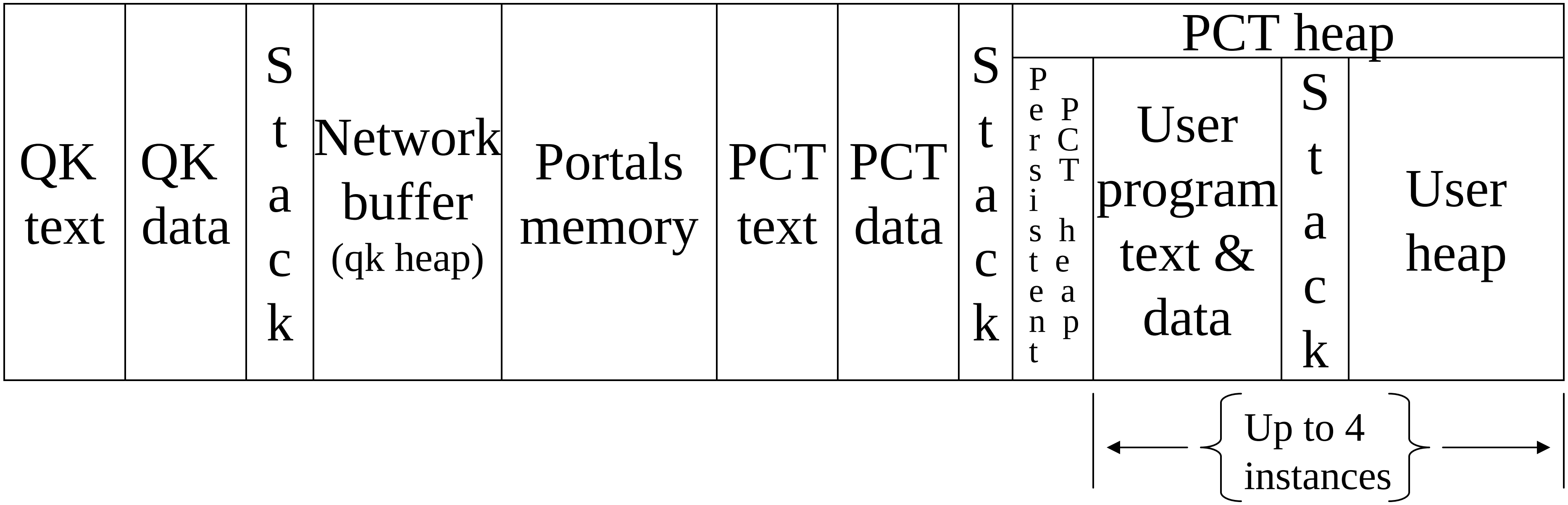
Network I/O Processors (Linux)

High Speed External Network

# Catamount General Structure



# Catamount Physical Memory layout



QK text

QK data

Stack

Network buffer (qk heap)

Portals memory

PCT text

PCT data

Stack

PCT heap

Persistent PCT heap

User program text & data

Stack

User heap

Up to 4 instances

Note: not to scale

# Quintessential Kernel (QK)

- Policy enforcer
- Initializes hardware
- Handles interrupts and exceptions
- Maintains hardware virtual addressing
- No virtual memory support
- Static size
- Non-blocking
- Few, well-defined entry points

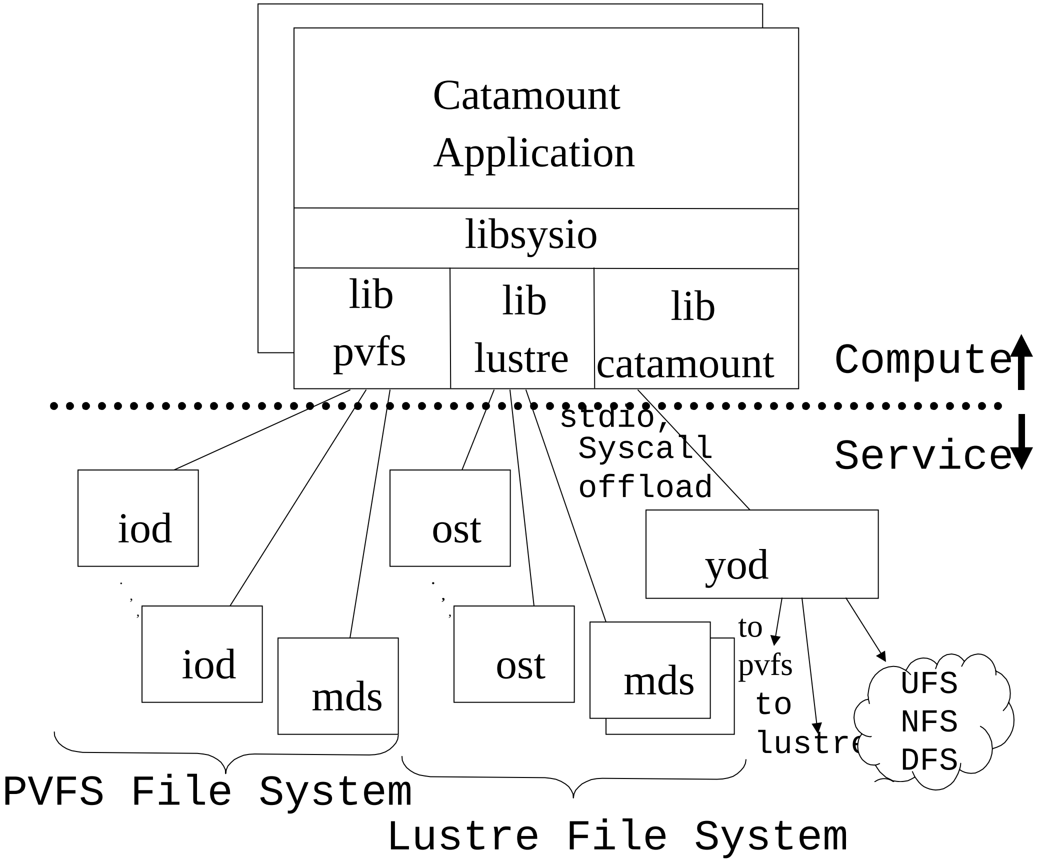
# Process Control Thread (PCT)

- Runs in user space
- More privileged than user applications
- Policy maker
  - Process loading (with yod)
  - Process scheduling
  - Virtual address space management
  - Fault handling
  - Signals

# Catamount’s libc is pruned version of glibc

- No threads support
- No off-node communication other than via Portals, such as pipes, sockets, rpc's or Internet Protocols
- No dynamic process creation; for example: no exec(), fork(), popen(), or system()
- No dynamic loading of executable code
- Limited signals support
- No /proc or ptrace
- No mmap.  A skeleton function is supplied, but returns –1.
- No profil()
- Limited ioctl
- No getpwd family of calls
- No functions requirement any form of db (e.g. ndb). For example, there is no support for the uid, gid family of queries that based on the ndb.
- No terminal control
- No functions that require UNIX-style daemons
- Custom catamount malloc is used by default

# Libsysio routes I/O calls to the appropriate file system handler



# Libcatamount

- RPC mechanism to communicate with yod for stdio and system call offload
- Custom malloc tuned for large allocations
- Pre-main initialization
- Interface routines for PCT and QK services

# Libportals

- Message passing API
- Separate software package
- Required by Catamount
- http://www.sourceforge.net/packages/sandiaportals

# YOD runs in the service partition

- Functions
  - Controls the logarithmic launch of a parallel job
  - Proxies standard I/O, plus other I/O, if necessary
  - Manages the parallel job throughout its run
- Yod is an evolution of the xnc (eXecute Network Computer) program used to launch jobs on the nCube: (x+1)(n+1)(c+1) = yod
- yod [ -Account project task ] [ -D option ] [ -help ] [{ -size | -sz | -np }{ n | all }] [ -stack size ] [ -tlimit secs ] [ -list processor-list ] [-strace] [-target { catamount | linux }] [ -share ] [ -heap size ] [ -Priority priority ] [-Version] progname [ progargs ] | -F loadfile

# Multi-Partition Job Support is new with Catamount

- Support for parallel applications that span Catamount and Linux
  - Yod using load file option (-F)
  - Requires a PCT to run on Linux
  - Requires different executables
  - Creates one MPI_COMM_WORLD

# Future Plans

- Re-introducing support for dual processors that removed in the port from cougar to catamount
- Studying whether catamount is viable for multi-core (> 2 CPUs) support